Project title:	Development of a Pheromone Trap for Monitoring Blackcurrant Sawfly
Project number:	SF 165
Project leader:	Dr Michelle Fountain, NIAB EMR
Report:	Year 1 Annual Report 2015
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Key staff:	Maddie Cannon (NIAB EMR) Prof David Hall, Dudley Farman (NRI)
Location of project:	NIAB EMR, NRI
Industry Representative:	Scott Raffle
Date project commenced:	April 2015
Date project completed (or expected completion date):	March 2017

The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

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CONTENTS

GROWER SUMMARY

Headline

The aim of the project was to develop a pheromone-baited trap for blackcurrant sawfly that can be used by growers to monitor populations so they can improve the timeliness and effectiveness of control measures and minimise insecticide residues in the crop.

Background

Blackcurrant sawfly is a common and frequently damaging pest of blackcurrant, present to varying degrees in all UK blackcurrant plantations. Larvae feed on foliage in May-June (1st generation) and July-August (2nd generation) making irregular holes in leaves and causing defoliation which weakens the bushes and causes substantial losses in yield. Larvae may also contaminate harvested fruit so good control prior to harvest is important.

Infestation is sporadic and localised and damage can occur rapidly. Frequent crop inspection is needed for first signs of eggs, larvae and damage. Current grower practice is application of a spray of insecticide as soon as eggs, larvae or damage is detected by crop scouting. No practical systematic sampling methods or attendant crop damage thresholds have been developed and it is believed that there is widespread unnecessary treatment. Adequate crop scouting is time-consuming and expensive, and a more sensitive and rapid monitoring method is needed. Pheromone traps could provide such a tool.

Non-UV reflective white sticky traps are used for monitoring various other Tenthredinid sawfly pests of fruit trees including apple sawfly, *Hoplocampa testudinea.* Female gooseberry sawfly, *Nematus ribesii,* were shown to produce a sex pheromone that attracts conspecific males, but, until recently, nothing was known about the chemical ecology of blackcurrant sawfly.

Development of a pheromone trap for blackcurrant sawfly was one of the objectives of the Hort LINK project “Developing Biocontrol Methods and their Integration in Sustainable Pest and Disease Management in Blackcurrant Production” (HL01105) 2010-2015. In this project, it was shown that male blackcurrant sawfly were attracted to virgin females, confirming the existence of a sex pheromone. Four potential pheromone components were detected, identified and synthesised. Three of these were produced only by females. They had structures unrelated to those of compounds reported as pheromone components in other sawfly species, but they caused very strong electroantennogram (EAG) responses from black currant sawfly males. The fourth compound was produced in large quantities by both females and males and did not elicit an EAG response.

Trapping tests were carried out with blends of these compounds on several growers' farms during 2013 and 2014. A blend of two of the three EAG-active compounds was shown to be highly attractive to male blackcurrant sawfly, and addition of the fourth component seemed to increase attractiveness even further. The trapping experiments also confirmed the sporadic nature of this pest in that few or no sawfly were caught on several of the farms.

Blackcurrant growers differ in their approach to sawfly control. Some spray prophylactically, often with chlorpyrifos or thiacloprid, and others apply no sprays for the pest. In trials in the previous HortLINK project it was noted that one of the latter growers had sawfly adults in the crop, detected using pheromone traps. Eggs and young larvae were found in the bushes, but no older larvae were found and no significant damage occurred. This may be because growers using fewer broad spectrum pesticides have a higher diversity of predators, particularly earwigs which are known to feed on a range of pest species in tree fruits (see HDC project Further development of earwig-safe spray programmes for apple and pear orchards: TF220). However this was not explored in the HortLINK project. In addition *Drosophila suzukii* (SWD) is likely to become an increasing pest of blackcurrant meaning that insecticide sprays used against this pest may disrupt predator numbers in blackcurrant crops at and near harvest. These factors have obvious implications for spray programmes and targeting of insecticide applications for sawfly control.

Summary

Field trials of pheromone trapping of blackcurrant sawfly were carried out in growers' blackcurrant fields. A replicated trial confirmed previous results that a three-component blend of two isopropyl esters, Z7-14iPr and Z7-iPr, and the unsaturated hydrocarbon, Z9-23H, is attractive to male blackcurrant sawfly. New results found that reducing the pheromone loading from 1 mg Z7-14iPr to 0.1 mg reduced catches and more sawfly were caught in red delta traps than green, at least for the most attractive blend. In a further trial to optimise the relative amount of Z7-16iPr in the blend, few blackcurrant sawfly were caught and no conclusions could be drawn. The different blends and traps were also tested in 3 other growers' fields but catches were low, and overall the results illustrated the sporadic and localised nature of this pest. Future work will focus on trap placement and the influence of natural enemies on this relationship will be determined.

Financial benefits

Blackcurrant sawfly is a common and frequently damaging pest of blackcurrant, present to varying degrees in all UK blackcurrant plantations. Larvae feed on foliage causing defoliation which weakens the bushes and causes substantial losses in yield. Larvae may also contaminate harvested fruit so good control prior to harvest is important.

Infestation is sporadic and localised and damage can occur rapidly. Frequent crop inspection is needed for first signs of eggs, larvae and damage. Current grower practice is application of a spray of insecticide as soon as eggs, larvae or damage is detected by crop scouting and it is believed there is widespread unnecessary treatment leading to risk of residues in the crop.

Chlorpyrifos and thiacloprid are both very effective against sawfly but chlorpyrifos has lost approval and the future of thiacloprid may be uncertain.

Adequate crop scouting is time-consuming and expensive, and a more sensitive and rapid monitoring method is needed. More effective monitoring would help to make more cost-effective use of insecticides currently available with a likely reduction in their use. Monitoring will be vital for effective use of any more benign, biological approaches developed in the future.

Pheromone traps could provide such a tool. Growers are generally familiar with this technology providing it is made readily available through commercial suppliers with adequate supporting information and protocols.

Action points

Growers should:

- Look for adults flying in April and May and target with approved insecticides to prevent egg laying;
- Check for eggs on the underside of leaves in the centre of the bush;
- Check for larval damage low down in the centre of the bush;
- Monitor the numbers of predators in the crop including earwigs and ladybirds etc and foster and encourage populations;
- Contact michelle.fountain@emr.ac.uk NIAB EMR, New Road, East Malling, Kent ME19 6BJ if they would like to trial the test trap and lure;

SCIENCE SECTION

Introduction

Blackcurrant sawfly is a common and frequently damaging pest of blackcurrant, present to varying degrees in all UK blackcurrant plantations. After overwintering, adults will emerge in late April or May. They are most active on warm sunny days laying their eggs on the underside of the blackcurrant plants leaves. Feeding at the base of the bushes, during May and June, hatched larvae (1st generation) develop through four or five larval instars (Mitchell et al., 2011). After spinning a cocoon, the pre-pupal stage falls to the ground and pupates in the soil. In July- August, second generation adults emerge. Developing larvae make irregular holes in leaves (Figure 1), causing defoliation which weakens the bushes and causes substantial losses in yield (Mitchell et al., 2011). Larvae may also contaminate harvested fruit so good control prior to harvest is important.

Figure 1. Blackcurrant sawfly damage on blackcurrant bush

Monitoring the pest relies on the detection of the eggs on the underside of leaves in the centre of the bushes and this egg laying may be aggregated within a plantation. Hence, crop scouting is not always reliable because doing an adequate search is time consuming. It is not uncommon for early infestations to be missed if the plantation is not well covered during an inspection.

In a previous Hort LINK project (Developing biocontrol methods and their integration in sustainable pest and disease management in blackcurrant production: HL01105), four potential components of the female sex pheromone of blackcurrant sawfly were identified and synthesised. Field tests suggested that three of these compounds were necessary for attraction of males. High catches of males were obtained in some fields and very low in others, confirming the sporadic nature of the pest.

This project will aim to optimise the pheromone blend, dispenser and trap and then to calibrate catches in the traps with field populations of blackcurrant sawfly. Factors affecting this relationship, such as the presence of predators and use of pesticides, will be investigated and thresholds for the two generations estimated. The trap will be made commercially available with a protocol for its use by growers. In this year we aimed to confirm the previous results, that addition of the hydrocarbon Z9-23H to the two isopropyl esters, Z7-14iPr and Z7-16iPr increased attractiveness, and also to determine the effect of pheromone loading in the lures.

Materials and Methods

Traps and Lures

Traps were delta traps (10 x 20 x 28 cm; Agrisense) in either red or green colours with white sticky bases. Pheromone components were synthesised at NRI and formulated in polyethylene vials (21 mm x 8 mm x 1.5 mm thick; Just Plastics) as slow release dispensers.

Field tests

Replicated experiments to compare pheromone blends and traps was carried out at a blackcurrant plantation in Horsemonden, Kent. There were five treatments with four pheromone blends (Table 1) and an unbaited control. The treatments were tested in red and green delta traps and there were five replicates. The experiment ran from 5 June – 16 July 2015 and catches were recorded on 19 June, 2 July and 16 July 2015. Lures were not changed during the experiment.

Traps were hung from a branch of the blackcurrant bushes in a place where the entrance of the traps was not obscured and the spray machinery would not damage the trap. Traps were at least 10 m apart along a row of bushes with at least 10 m between replicates.

Table 1. Blends of three pheromone components evaluated in field trials (isopropyl (*Z*)-7-tetradecenoate Z7-14iPr; isopropyl (*Z*)-7-hexadecenoate Z7-16iPr; (*Z*)-9-tricosene Z9-23H)

	Loading (mg)		
Treatment	Z7-14iPr	Z7-16iPr	Z9-23H
Field Test 1, 2			
A	1.0	0.5	
B	1.0	0.5	5.0
C	0.1	0.05	
D	0.1	0.05	0.5
Field Test 3			
A	1.0		5.0
B	1.0	0.05	5.0
C	1.0	0.1	5.0
D	1.0	0.2	5.0
E	1.0	0.5	5.0
F	1.0	1.0	5.0

Results

The blends were tested in red and green delta traps to investigate the effect of trap colour as previous trials had used red delta traps only.

The results (Figure 2) confirmed that addition of the hydrocarbon component increased catches and showed that reducing the pheromone loading from 1 mg of Z7-14iPr to 0.1 mg decreased catches. Catches were higher in red delta traps than in green for the most attractive blend but not for the other blends tested. No sawfly were caught in unbaited traps.

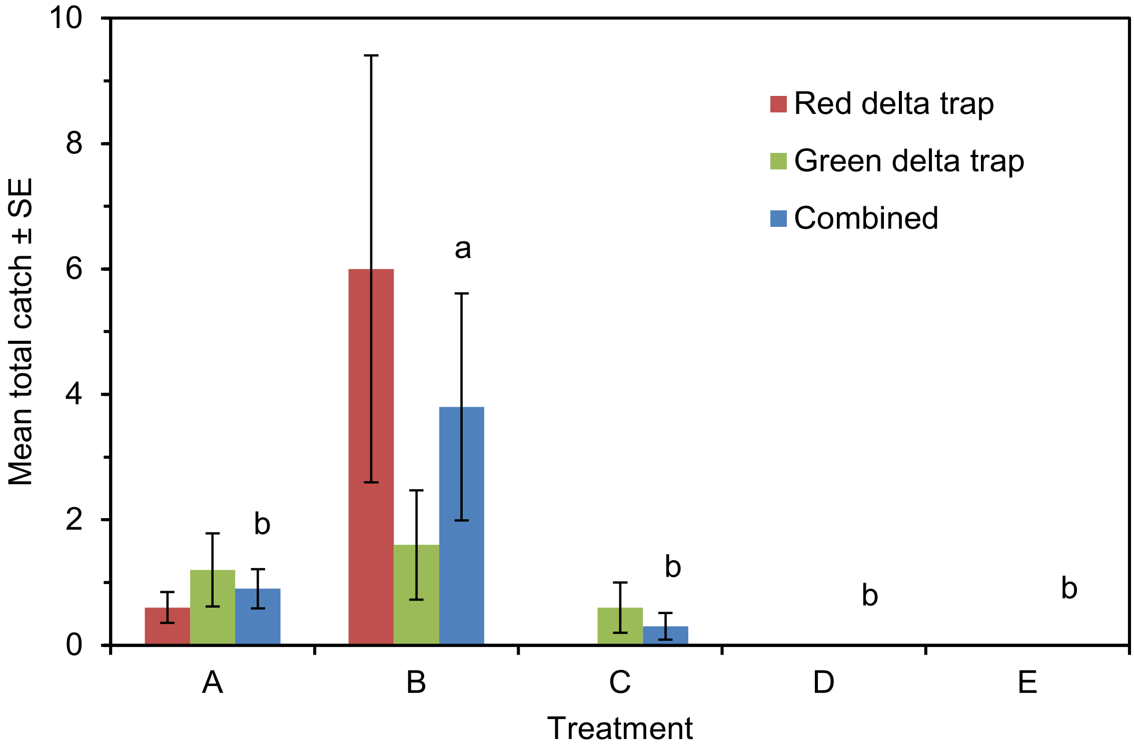

Figure 2. Catches of male blackcurrant sawfly at Horsmonden 5 June – 16 July 2015 (A 1 mg Z7-14iPr + 0.5 mg Z7-16iPr; B 1 mg Z7-14iPr + 0.5 mg Z7-16iPr + 5 mg Z9-23H; C 0.1 mg Z7-14iPr + 0.05 mg Z7-16iPr; 0.1 mg Z7-14iPr + 0.05 mg Z7-16iPr + 0.5 mg Z9-23H; E unbaited; 5 reps each trap colour; bars with different letters are significantly different at $P < 0.05$ by LSD test after ANOVA on data transformed to log(x+1))

Catches of blackcurrant sawfly were highest at the beginning of the trial in June and decreased in July (Figure 3). At Horsemonden 2 sawfly were caught in each of treatments A and D, and at at site in Scotland 11 were caught in treatment D. No independent measurements of infestation with blackcurrant sawfly were made.

In the third trial set up at Horsmonden to optimise the proportion of Z7-16iPr in the three-component pheromone blend, unfortunately only 3 blackcurrant sawfly were caught during the whole period, at least in part because the field had been sprayed with insecticide.

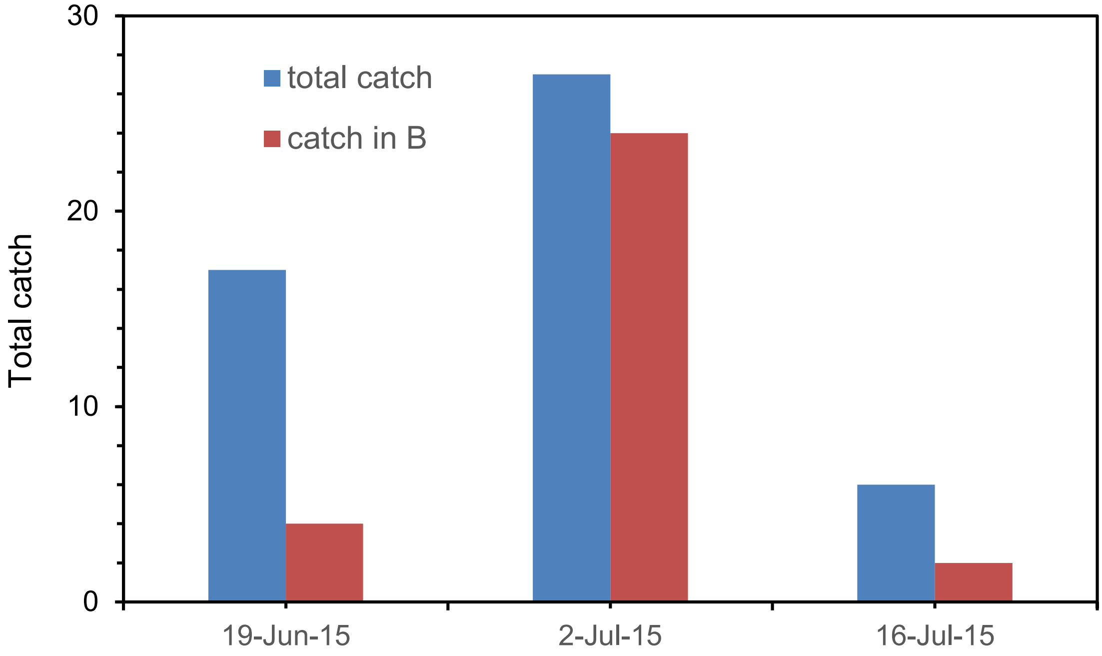

Figure 3. Catches of male blackcurrant sawfly at Horsemonden 5 June – 16 July 2015

Discussion

Results obtained during 2015 confirmed previous results that a three-component blend of two isopropyl esters, Z7-14iPr and Z7-iPr, and the unsaturated hydrocarbon, Z9-23H, is attractive to male blackcurrant sawfly. New results were that reducing the pheromone loading from 1 mg Z7-14iPr to 0.1 mg reduced catches and that more sawfly were caught in red delta traps than green, at least for the most attractive blend. In a further trial to optimise the relative amount of Z7-16iPr in the blend, few blackcurrant sawfly were caught and no conclusions could be drawn.

Catches were low in trials carried out in other growers' fields, and overall the results illustrated the sporadic and localised nature of this pest.

Conclusions

- The three-component pheromone blend of two isopropyl esters, Z7-14iPr and Z7-16iPr, with the unsaturated hydrocarbon, Z9-23H, dispensed from a polyethylene vial at 1 mg Z7-14iPr loading is attractive to male blackcurrant sawfly.
- Male blackcurrant sawfly were caught in both red and green delta traps, significantly more in the red with the most attractive pheromone blend.
- Future work will use the three component blend in red delta traps and investigate the relationship between trap catches, infestation with blackcurrant sawfly and numbers of natural enemies.
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Knowledge and Technology Transfer

- Components of the sex pheromone of blackcurrant sawfly, *Nematus olfaciens* (Hymenoptera: Tenthredinidae): novel *iso*propyl esters and the role of hydrocarbons. David Hall, Dudley Farman, Paul Douglas, Jerry Cross, Michelle Fountain, Bethan Shaw. Presentation at IOBC Meeting "Pheromones and Other Semio-Chemicals in Integrated Production", Jerusalem, Israel, November 2015.
- Developing sex pheromone monitoring traps for gooseberry and blackcurrant sawfly. David Hall. ADHB Soft Fruit Agronomists' Davy, EMR 11 February 2016.